

WHAT IS CLAIMED IS:

1. A semiconductor memory device comprising:

a plurality of memory cells each of which includes
a first MOS transistor with a charge accumulation layer
and a control gate and a second MOS transistor which
has one end of its current path connected to one end of
a current path of the first MOS transistor;

5 a plurality of local bit lines each of which
connects other ends of the current paths of the first
MOS transistors;

10 a global bit line to which two or more of the
local bit lines are connected in common;

15 a first switch element which makes a connection
between the local bit lines and the global bit line;
and

20 a holding circuit which is connected to the global
bit line and holds data to be written into the memory
cells.

2. The semiconductor memory device according to

claim 1, further comprising:

word lines each of which connects the control
gates of plurality of the memory cells in common,
wherein

25 the data is written into the plurality of memory
cells connected to the same one of the word lines are
written into at the same time.

3. The semiconductor memory device according to

claim 1, wherein the data is written into the memory cells by exchanging electrons with the charge accumulation layer by FN tunneling.

4. The semiconductor memory device according to
5 claim 1, further comprising:

a sense amplifier which amplifies read data,
wherein

the global bit line includes a write global bit line and a read global bit line,

10 the first switch element includes a second switch which makes a connection between the write global bit line and the local bit lines and a third switch element which makes a connection between the read global bit line and the local bit lines,

15 the holding circuit is connected to the write global bit line, and

the sense amplifier is connected to the read global bit line.

5. The semiconductor memory device according to
20 claim 4, wherein the third switch element includes

a third MOS transistor which has one end of its current path connected to the local bit lines and the other end of its current path, and

25 a fourth MOS transistor which has one end of its current path connected to the other end of the current path of the third MOS transistor, other end of its current path connected to the read global bit line and

a gate insulating film thinner than that of the third MOS transistor.

6. The semiconductor memory device according to claim 4, wherein the potential of the write global bit line is set at the ground potential in a read 5 operation.

7. The semiconductor memory device according to claim 1, further comprising:

10 a sense amplifier which is connected to one end of the global bit line and amplifies read data; and

15 a third MOS transistor which has one end of its current path connected to the connection node of the local bit lines and the first switch element and the other end of its current path connected to a first potential, wherein

the holding circuit is connected to the other end of the global bit line, and

20 the gates of the third MOS transistors connected to the local bit lines sharing the global bit line are independent of one another.

8. The semiconductor memory device according to claim 1, further comprising:

25 a source line to which the other ends of the current paths of the second MOS transistors in the memory cells are connected in common; and

a source line driver which supplies a potential to the source line.

9. The semiconductor memory device according to
claim 1, wherein a negative voltage is applied to the
local bit lines in a write operation and a negative
voltage is applied to the control gate of the first MOS
5 transistor in an erase operation.

10. The semiconductor memory device according to
claim 1, further comprising:

10 a plurality of cell blocks including two columns
of the memory cells connected to two of the local bit
lines respectively; and

a sense amplifier which amplifies the data read
from the memory cells, wherein

each of the global bit lines includes two write
global bit lines and one read global bit line,

15 the first switch element includes a second and a
third switch element, and

in each of the cell blocks, two of the local bit
lines are connected to the two write global bit lines
via the second switch respectively and are connected to
20 the one read global bit line via the third switch
element in common,

the holding circuit is connected to each of the
write global bit lines, and

25 the sense amplifier is connected to each of the
read global bit lines.

11. The semiconductor memory device according to
claim 1, further comprising:

a plurality of cell blocks including four columns of the memory cells connected to four of the local bit lines respectively; and

5 a sense amplifier which amplifies the data read from the memory cells, wherein

each of the global bit lines includes two write global bit lines and one read global bit line,

the first switch element includes a second and a third switch element, and

10 in each of the cell blocks, two of the local bit lines are connected in common to one of the write global bit lines via the second switch element, the remaining two local bit lines are connected in common to the other of the write global bit lines via the 15 second switch element, and the read global bit line is connected to all of the four local bit lines via the third switch element,

the holding circuit is connected to each of the write global bit lines, and

20 the sense amplifier is connected to each of the read global bit lines.

12. The semiconductor memory device according to claim 1, further comprising:

25 a plurality of cell blocks including two columns of the memory cells connected to two of the local bit lines respectively;

a second switch element which is provided for each

of the cell blocks and makes a connection between the two local bit lines and a first potential node; and a sense amplifier which amplifies the data read from the memory cells, wherein

5 in each of the cell blocks, two of the local bit lines are connected in common to the global bit line via the first switch and, in a write operation, one of the local bit lines is connected to the global bit line by the first switch and disconnected from the first potential node by the second switch and the other of the local bit lines is connected to the first potential node by the second switch and disconnected from the global bit line by the first switch, and in a read operation, one of the local bit lines is connected to the global bit line by the first switch and the other of the local bit lines is disconnected from the global bit line by the first switch, and

10 the holding circuit is connected to one end of the global bit line and the sense amplifier is connected to the other end of the global bit line.

15 the holding circuit is connected to one end of the global bit line and the sense amplifier is connected to the other end of the global bit line.

20 the holding circuit is connected to one end of the global bit line and the sense amplifier is connected to the other end of the global bit line.

13. The semiconductor memory device according to claim 1, further comprising:

25 a plurality of cell blocks including four columns of the memory cells connected to four of the local bit lines respectively;

 a second switch element which is provided for each of the cell blocks and makes a connection between the

four local bit lines and a first potential node; and
a sense amplifier which amplifies the data read
from the memory cells, wherein

in each of the cell blocks, four of the local bit
5 lines are connected in common to the global bit line
via the first switch and, in a write operation, any one
of the local bit lines is connected to the global bit
line by the first switch and disconnected from the
first potential node by the second switch and the
10 remaining three local bit lines are connected to the
first potential node by the second switch and
disconnected from the global bit line by the first
switch, and in a read operation, any one of the local
bit lines is connected to the global bit line by the
15 first switch and the remaining three local bit lines
are disconnected from the global bit line by the first
switch, and

the holding circuit is connected to one end of the
global bit line and the sense amplifier is connected to
20 the other end of the global bit line.

14. The semiconductor memory device according to
claim 1, wherein the global bit line is made of a metal
wiring layer located at the highest level in a memory
cell array which has the memory cells arranged in
25 a matrix.

15. A semiconductor memory device comprising:
a plurality of memory cells each of which includes

a first MOS transistor with a charge accumulation layer and a control gate;

word lines to which the control gates of two or more of the memory cells are connected in common, the
5 data being written into two or more of the memory cells connected to the same word line at the same time by exchanging electrons with the charge accumulation layer by FN tunneling;

10 a plurality of local bit lines to which one end of a current path of the first MOS transistor of each of two or more of the memory cells is connected;

a global bit line to which two or more of the local bit lines are connected in common;

15 a first switch element which makes a connection between the local bit lines and the global bit line; and

a holding circuit which is connected to the global bit line and holds data to be written into the memory cells.

20 16. The semiconductor memory device according to claim 15, wherein each of the memory cells further includes a second MOS transistor which has one end of its current path connected to the other end of the current path of the first MOS transistor.

25 17. The semiconductor memory device according to claim 15, further comprising:

a sense amplifier which amplifies read data,

wherein

the global bit line includes a write global bit line and a read global bit line,

5 the first switch element includes a second switch which makes a connection between the write global bit line and the local bit lines and a third switch element which makes a connection between the read global bit line to the local bit lines,

10 the holding circuit is connected to the write global bit line, and

the sense amplifier is connected to the read global bit line.

18. The semiconductor memory device according to claim 17, wherein the third switch element includes a 15 third MOS transistor which has one end of its current path connected to the local bit lines and the other end of its current path, and

20 a fourth MOS transistor which has one end of its current path connected to the other end of the current path of the third MOS transistor, the other end of the current path connected to the read global bit line and a gate insulating film thinner than that of the third MOS transistor.

19. The semiconductor memory device according to 25 claim 17, wherein the potential of the write global bit line is set at the ground potential in a read operation.

20. The semiconductor memory device according to
claim 15, further comprising:

a sense amplifier which is connected to one end of
the global bit line and amplifies read data; and

5 a third MOS transistor has one end of its current
path connected to the connection node of the local bit
lines and the first switch element and the other end of
its current path connected to a first potential,
wherein

10 the holding circuit is connected to the other end
of the global bit line, and

the gates of the third MOS transistors connected
to the local bit lines sharing the global bit line are
independent of one another.

15 21. The semiconductor memory device according to
claim 15, further comprising:

a source line to which the other ends of the
current paths of the second MOS transistors in the
memory cells are connected in common; and

20 a source line driver which supplies a potential to
the source line.

22. The semiconductor memory device according to
claim 15, wherein a negative voltage is applied to the
local bit lines in a write operation and a negative
voltage is applied to the control gate of the first MOS
25 transistor in an erase operation.

23. The semiconductor memory device according to

claim 15, further comprising:

a plurality of cell blocks including two columns of the memory cells connected to two of the local bit lines respectively; and

5 a sense amplifier which amplifies the data read from the memory cells, wherein

each of the global bit lines includes two write global bit lines and one read global bit line,

10 the first switch element includes a second and a third switch element, and

in each of the cell blocks, two of the local bit lines are connected to the two write global bit lines via the second switch element respectively, and the read global bit line is connected via the third switch 15 element to the two local bit lines,

the holding circuit is connected to each of the write global bit lines, and

the sense amplifier is connected to each of the read global bit lines.

20 24. The semiconductor memory device according to claim 15, further comprising:

a plurality of cell blocks including four columns of the memory cells connected to four of the local bit lines respectively; and

25 a sense amplifier which amplifies the data read from the memory cells, wherein

each of the global bit lines includes two write

global bit lines and one read global bit line,

the first switch element includes a second and a third switch element, and

in each of the cell blocks, two of the local bit
5 lines are connected in common to one of the write global bit lines via the second switch element, the remaining two local bit lines are connected in common to the other of the write global bit lines via the second switch element, and the read global bit line is
10 connected to all of the four local bit lines via the third switch element,

the holding circuit is connected to each of the write global bit lines, and

15 the sense amplifier is connected to each of the read global bit lines.

25. The semiconductor memory device according to claim 15, further comprising:

a plurality of cell blocks including two columns of the memory cells connected to two of the local bit
20 lines respectively;

a second switch element which is provided for each of the cell blocks and makes a connection between the two local bit lines and a first potential node; and

25 a sense amplifier which amplifies the data read from the memory cells, wherein

in each of the cell blocks, two of the local bit lines are connected in common to the global bit line

via the first switch and, in a write operation, one of
the local bit lines is connected to the global bit line
by the first switch and disconnected from the first
potential node by the second switch and the other of
5 the local bit lines is connected to the first potential
node by the second switch and disconnected from the
global bit line by the first switch, and in a read
operation, one of the local bit lines is connected to
the global bit line by the first switch and the other
10 of the local bit lines is disconnected from the global
bit line by the first switch, and

the holding circuit is connected to one of the
global bit line and the sense amplifier is connected to
the other end of the global bit line.

15 26. The semiconductor memory device according to
claim 15, further comprising:

a plurality of cell blocks including four columns
of the memory cells connected to four of the local bit
lines respectively;

20 a second switch element which is provided for each
of the cell blocks and makes a connection between the
four local bit lines and a first potential node; and
 a sense amplifier which amplifies the data read
from the memory cells, wherein

25 in each of the cell blocks, four of the local bit
lines are connected in common to the global bit line
via the first switch and, in a write operation, any one

of the local bit lines is connected to the global bit line by the first switch and disconnected from the first potential node by the second switch and the remaining three local bit lines are connected to the 5 first potential node by the second switch and disconnected from the global bit line by the first switch, and in a read operation, any one of the local bit lines is connected to the global bit line by the first switch and the remaining three local bit lines 10 are disconnected from the global bit line by the first switch, and

the holding circuit is connected to one of the global bit line and the sense amplifier is connected to the other end of the global bit line.

15 27. The semiconductor memory device according to claim 15, wherein the global bit line is made of a metal wiring layer located at the highest level in a memory cell array which has the memory cells arranged in a matrix.

20 28. A semiconductor memory device comprising:
 a plurality of memory cells each of which includes a first MOS transistor with a charge accumulation layer and a control gate and a second MOS transistor which has one end of its current path connected to one end of 25 a current path of the first MOS transistor;

a plurality of cell blocks in each of which the memory cells are arranged in a matrix;

a memory cell array which has the cell blocks arranged in a matrix;

5 a plurality of local bit lines to which the other ends of the current paths of the first MOS transistors of the memory cells in the same column are connected in common in each of the cell blocks;

a plurality of global bit lines to which the local bit lines in the same column are connected in common in the memory cell array;

10 a first switch element which makes a connection between the local bit lines and the global bit lines; and

15 a holding circuit which is connected to each of the global bit lines and holds data to be written into the memory cells.

29. The semiconductor memory device according to claim 28, further comprising:

word lines to which the control gates of the memory cells in the same row are connected in common, 20 wherein

the data is written into the plurality of memory cells connected to the same one of the word lines at the same time.

30. The semiconductor memory device according to claim 28, wherein the data is written into the memory cells by exchanging electrons with the charge accumulation layer by FN tunneling.

31. The semiconductor memory device according to
claim 28, further comprising:

a sense amplifier which amplifies read data,
wherein

5 the global bit lines include write global bit
lines and read global bit lines,

the first switch element includes a second switch
which makes a connection between the write global bit
lines and the local bit lines and a third switch
10 element which makes a connection between the read
global bit lines and the local bit lines,

the holding circuit is connected to the write
global bit lines, and

the sense amplifier is connected to the read
15 global bit lines.

32. The semiconductor memory device according to
claim 31, wherein the third switch element includes
a third MOS transistor which has one end of its current
path connected to the local bit lines and the other end
20 of its current path, and

a fourth MOS transistor which has one end of its
current path connected to the other end of the current
path of the third MOS transistor, the other end of its
current path connected to the read global bit lines and
25 a gate insulating film thinner than that of the third
MOS transistor.

33. The semiconductor memory device according to

claim 31, wherein the potential of the write global bit line is set at the ground potential in a read operation.

34. The semiconductor memory device according to
5 claim 28, further comprising:

a sense amplifier which is connected to one end of the global bit line and amplifies read data; and

10 a third MOS transistor has one end of its current path connected to the connection node between the local bit lines and the first switch element and the other end of its current path connected to a first potential, wherein

the holding circuit is connected to the other end of the global bit line, and

15 the gates of the third MOS transistors connected to the local bit lines sharing the global bit line are independent of one another.

35. The semiconductor memory device according to
claim 28, further comprising:

20 a source line to which the other ends of the current paths of the second MOS transistors in the memory cells are connected in common; and

a source line driver which supplies a potential to the source line.

25 36. The semiconductor memory device according to
claim 28, wherein a negative voltage is applied to the local bit lines in a write operation and a negative

voltage is applied to the control gate of the first MOS transistor in an erase operation.

37. The semiconductor memory device according to claim 28, wherein the global bit lines are made of a metal wiring layer located at the highest level in the memory cell array which has the memory cells arranged in a matrix.